Patent claims

1 Microreactor for performing heterogeneous catalytic reactions, having a multiplicity of chambers in vertical or horizontal and essentially parallel arrangement, each being equipped with at least one feed line and one discharge, the feed lines being connected to at least one manifold and the discharges to at least one header, the chambers being formed by stacked plates or layers, and one part of the chambers representing reaction chambers and the other part of the chambers representing heat carrier chambers, the heat transport between reaction and heat carrier chambers taking place through at least one common chamber wall formed by a common plate, with spacers being arranged in all chambers, characterized in that catalyst material is applied at least in part to the internal walls of the reactor chambers, whereby the hydraulic diameter, defined as the quotient of the four-fold area to the circumferential length of the cross section of free flow, in the reaction chambers is smaller than 4000 µm and advantageously smaller than 1500 µm and ideally smaller than 500 µm, and the ratio between the smallest perpendicular distance between two neighboring spacers to the slot height of the reaction chamber after coating with catalyst is smaller than 800, preferentially smaller than 450 and ideally smaller than 100, and greater than or equal to 10.

2 Device in accordance with claim 1, characterized in that the spacers are rotationally symmetric, droplet-shaped, rhombic or advantageously designed as webs and ideally as continuous webs.

3 Device in accordance with claims 1 or 2, characterized in that the share of the standing or base area of the spacers in relation to the area of the plate lying within the circumferential gaskets and welded or soldered sealing seams terminating the reaction chambers or heat carrier chambers equals at least 2.5%, lies preferably in the range from 5% to 15% and does not exceed 30%.

4 Device in accordance with claims 1 to 3, characterized in that spacers constructed as webs or continuous webs have a web width greater than or equal to 1000 µm and are not wider than 6000 µm.

5 Device in accordance with claims 1 to 4, characterized in that the catalytic material is applied in a slot essentially on the plate.

6 Device in accordance with the claims 1 to 5, characterized in that at least partial areas of the manifold and/or header are coated with catalytic material or are made of material with a catalytic effect.

7 Device in accordance with the claims 1 to 6, characterized in that the material of at least a partial area of the chamber wall or the spacers has a catalytic effect.

8 Device in accordance with the claims 1 to 7, characterized in that feed lines and discharges of the reaction and heat carrier chambers are arranged to result in a co-directional, counter-directional or meandering throughflow in relation to the next chamber.

9 Device in accordance with the claims of 1 to 8, characterized in that the plates have recesses in the reaction chambers, in which at least part of the catalyst material is inserted, the recesses being able to assume any shape and being designed advantageously in groove form and ideally always extending exactly in one gap.

10 Device in accordance with the claims of 1 to 9, characterized in that the webs of two plates are arranged facing each other so that the webs form an angle of 0° to 90° with each other and ideally are arranged parallel with and directly above each other.

11 Device in accordance with the claims of 1 to 10, characterized in that provision is made for at least one device at the entrance to and inside the reaction chambers in flow direction, which reduces the free cross sectional area perpendicular to the direction of the main stream, the device having a random shape.

12 Device in accordance with the claims of 1 to 11, characterized in that provision is made for at least one area in the entrance to and inside the reaction chambers in which at least two fluids are mixed, whereby at least one fluid is injected essentially perpendicular to the direction of the main stream and a homogenization section is arranged after the injection.

13 Device in accordance with the claim 12, characterized in that a fluid is injected through bores in the chamber wall, which are inclined at an angle of -60° to +60° and ideally at an angle of -30° to +30° in relation to the perpendicular to the direction of the main stream and are connected by means of at least one fluid channel extending essentially transverse to the direction of the main stream.

14 Device in accordance with the claims of 1 to 13, characterized in that provision is made for at least one device at the end of the reaction chambers in flow direction, which reduces the free cross sectional area perpendicular to the direction of the main stream, the device having a random shape and being constructed advantageously of a multiplicity of spacers, as extensions of the web widths or as baffles and ideally as a reduction of the gap height.

15 Device in accordance with claims 14, characterized in that the pressure loss due to the cross sectional constriction at the outlet of the plates has to be greater than the fluctuation of the pressure difference resulting from the production tolerances of the catalyst layer and/or the gap by at least the factor 5.

16 Processes for the use of the device in accordance with the claims 1 to 15, characterized in that the processes lie at differential pressures between the reaction and heat carrier chambers of 0 bar to 15 bar and ideally between 0 bar and 5 bar.

17 Processes for the use of the device in accordance with the claims 1 to 16, characterized in that liquid or gaseous media are passed through in the heat carrier chambers.

18 Processes for the use of the device in accordance with the claims 1 to 17, characterized in that the media in the heat carrier chambers change their aggregate condition completely or partly while passing through.

19 Process for the use of the device in accordance with the claims 1 to 18, characterized in that the process is used at temperatures below 500 °C and also at temperatures below 0 °C.

20 Process in accordance with one of the claims 16 to 19, characterized in that it is used for the synthesis of hydrocarbon compounds and particularly of oxygenates of hydrocarbon compounds.

21 Process in accordance with one of the claims 16 to 19, characterized in that it is used for the synthesis of propylene oxide from essentially hydrogen peroxide and propene.

22 Process in accordance with one of the claims 16 to 19, characterized in that it is used for the synthesis of phenol.

23 Process in accordance with one of the claims 16 to 19, characterized in that it is used for the synthesis of hydrogen peroxide from essentially hydrogen and oxygen.